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IS 9275 (1996): Horology - Radio luminescence for Timekeeping Instruments [PGD 23: Horology]

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(पहला पुनरीक्षण)

Indian Standard

HOROLOGY — RADIOLUMINESCENCE FOR TIMEKEEPING INSTRUMENTS — SPECIFICATION

(First Revision)

ICS 39.040

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 3

Horology Sectional Committee, LM 23

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Horology Sectional Committee had been approved by the Light Mechanical Engineering Division Council.

This standard was originally published in 1979. This revision is based on further technical developments in this field . In this revision the Swipe Test for Luminous painted dials has been added and the test procedure for Resistance to Ageing has been revised to bring in line with International Standard.

This Standard specifies the requirements for the optical, mechanical and radioactive characteristics of the radioluminesent materials used on time keeping instruments. This also states the conditions for carrying out the tests together with the methods of tests relating to various requirements. This standard also covers the technical informations of the radioluminescent materials and their application on the time keeping devices that is wrist watches, clocks and time pieces.

In the preparation of this standard necessary assistance has been derived from ISO 3157 : 1991 'Radioluminescence for time measurement instruments — Specification' and ISO 4168 : 1979 'Time measurement instruments — Conditions for carrying out checks on radioluminescent deposits', published by the International Organization for Standardization (ISO).

In addition to the requirements of this standard, the manufacture and use of radioluminescent substance shall conform to the Radiation Protection Rules — 1971 as promulgated by the Government of India (Directorate of Radiation Protection Division — BARC) and any subsequenent notification issued thereto.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding of numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

HOROLOGY — RADIOLUMINESCENCE FOR TIMEKEEPING INSTRUMENTS — SPECIFICATION

(*First Revision*)

1 SCOPE

1.1 Specifies requirements for the optical, mechanical and radioactive characteristics of the radioluminescent deposits fixed on timekeeping instruments, together with the methods of test relating to them and the conditions for carrying out checks on radioluminescent deposits and radiation protection limits for radioactive paints.

1.2 The requirements apply to all timekeeping instruments which include components like hands, dials, bezels, etc, bearing radioluminescent deposits.

1.3 It also covers the deposits themselves, whether they are fixed on the timekeeping instruments in question, or on special supports.

1.4 This standard shall not constitute an exemption from the obligation of notification, declaration and licensing in connection with the manufacture, maintenance, repair, storage, transport, import/export and disposal of time pieces containing components bearing radioluminous paint. Such operations shall be carried out in accordance with national norms for radiation protection.

1.5 This standard is not intended to cover radiation protection aspects for special time pieces containing quantities of radioactive materials which exceed the limits specified in this standard. These shall be subject to the jurisdiction of the appropriate national authority.

2 TERMINOLOGY

2.1 Bremsstrahlung

Secondary photon radiation produced by deceleration of charged particles passing through matter.

2.2 Luminous Flux

It is the total visible energy emitted by a source per unit time. The unit of measurement of luminous flux is 'lumen' and is defined as the flux emitted with a unit solid angle of one steradian by a point source having a uniform intensity of one candela (*see* 2.3).

2.3 Candela (cd)

It is the unit of luminous intensity and is defined as the luminous intensity, in the perpendicular direction, of a surface of 1/600 000 square metre of a black body at the temperature of freezing platinum (2046.65°K) under a pressure of 101.325 kPa.

2.4 Curie (Ci)

It is the unit of activity and is defined as the activity of that quantity of a radioactive nuclide in which the number of disintegrations per second is 3.7×10^{10}

1 millicurie = 10^{-3}Ci
1 microcurie = 10^{-6}Ci
1 mCi = 37 MBq (Mega Becquerel)

2.5 New Deposit

Any part (hand, dial, bezel) which owing to nature of the materials and the treatments of the surface, is outside the previous experience of the user of the radioluminescent substance.

2.6 New Support

Any deposit of radioluminescent substance which, to its shape or dimensions is outside the previous experience of the user of the radioluminescent substance.

2.7 Radioluminescence

Luminescence caused by the radiation of a radionuclide within certain crystalline powder (ZnS, Zn_2SiO_4 etc).

2.8 Radioluminescent Deposit

A radioluminescent substance in powder form mixed with a binder and fixed on a support.

2.9 Special Timekeeping Instruments

Instruments designed for uses which require considerable luminosity. They are generally used or worn intermittently. Becuase of this, the quantity of radioactive substance used is greater.

3 SPECIFICATION AND METHODS OF TEST FOR TIMEKEEPING INSTRUMENTS

3.1 Legibility

3.1.1 For watches using radioluminescent substances, the following quality criteria shall apply:

a) At least four hour markings shall be used. It is permissible to use only three, however, when the instrument includes an aperture;
b) 12 shall be differentiated from the other markings;
c) The hour-hand shall be differentiated from the minute-hand;
d) If only four markings are used, the total luminous intensity, that is, that of the whole (hands + markings) shall be at least 25 nanocandelas. However, in the case of three markings, permitted above, this lower limit is reduced to 22 nanocandelas;
e) If more than four markings are used, the above threshold is increased by three nanocandelas per additional marking; and
f) The pair of hands, taken in isolation, shall have a luminous intensity of 10 nanocandelas or more.

3.1.2 For timekeeping instruments not worn on the person, the minimum values of the luminous intensities above shall be doubled; **3.1.1** (a), (b) and (c) shall also remain valid.

3.2 Nature of Radionuclides

3.2.1 Only the following radionuclides shall be used:

Tritium	^{3}H	for marking: T
Promethium	^{147}Pm	for marking: Pm

3.2.2 The use of different radionuclides on the same timekeeping instrument is prohibited.

3.3 Total Radioactivity

For each category of instrument and type of radionuclide, the maximum values authorized for the mean radioactivity of the instruments of a lot and the radioactivity of an instrument considered individually shall be as given in Tables 1 to 4.

Table 1 Radioactivity of Timekeeping Instruments Worn on Wrist

Radionuclide	Maximum Activity of a Lot (per Instrument)	Maximum Activity of an Isolated Instrument
^{3}H	5 mCi	7.5 mCi
^{147}Pm	0.1 mCi	0.15 mCi

Table 2 Radioactivity of Timekeeping Instruments Worn Elsewhere than on Wrist

Radionuclide	Maximum Activity of a Lot (per Instrument)	Maximum Activity of an Isolated Instrument
^{3}H	5 mCi	7.5 mCi
^{147}Pm	0.1 mCi	0.15 mCi

Table 3 Radioactivity of Timekeeping Instruments Not Worn or Carried on the Person

Radionuclide	Maximum Activity of a Lot (per Instrument)	Maximum Activity of an Isolated Instrument
^{3}H	7.5 mCi	10 mCi
^{147}Pm	0.15 mCi	0.2 mCi

Table 4 Radioactivity of Special Timekeeping Instruments

Radionuclide	Maximum Activity of an Isolated Instrument
^{3}H	25 mCi
^{147}Pm	0.5 mCi

3.4 Protection Against Radioactivity

3.4.1 The case, glass and protective varnish of the timekeeping instrument shall be so constituted that the user is protected against any direct contact with the components treated with radioluminescent material and that the low energy β-radiations are sufficiently absorbed.

3.4.2 In any case, any deposit of radioluminescent material shall be protected by a thickness of transparent non-radioactive material equal to 50 mg/cm^2 or more.

3.4.2.1 The mechanical strength of this protection shall be sufficient to bear the stresses encountered under normal conditions of use and as far as reasonably practicable, during possible accidents.

3.5 Checking of Radioactivity

3.5.1 The activity shall be checked, in relation to the requirements specified in **3.3** on the timekeeping instrument fitted with its normal protection (glass). A method based on photometric measurement is authorized. If the measurement of the *Bremsstrahlung* (T, Pm) is used, account shall be taken of the attenuation due to the glass and to the deposit itself. The thicknesses of the glass and the deposit are either measured or estimated by convention at 50 mg/cm^2 each. This shall be without prejudice to the requirements specified in **3.4**.

3.5.2 When uncertainty resulting from the above mentioned methods of checking makes it impossible to guarantee that the requirements specified in **3.3** are complied with, a destructive method shall be used to measure the activity. Such a destructive method shall consist in isolating the radionuclide from the other constituents of the luminescent substance, or from the deposit, and converting it into a form suitable for as accurate a measurement as possible to be made.

NOTE – For example, for tritiated substances, a suitable method consists in destruction of the luminescent deposit by combustion, collection of the liberated water and measurement of its activity with a liquid scintillator.

4 MARKING

4.1 Marking is obligatory only for special timekeeping instruments. It is intended for the information of the horologist as well as the user.

4.2 It shall be effected, legibly and indelibly, on the dial of the instrument.

4.3 It shall comprise one of the two following indications:

a) T 25 for deposits activated by tritium, and
b) Pm0.5 for deposits activated by promethium.

4.3.1 These indications give the value, in millicuries for tritium and promethium deposits, of the maximum authorized radioactivity.

4.3.2 For the other time measurement instruments, the marking can be made on the dial by the letters T or Pm.

4.4 Checking of Marking

Marking shall be checked by visual inspection.

5 METHODS OF TESTS FOR RADIOLUMINESCENT DEPOSITS

5.1 The deposits may be checked, unless special restrictions are indicated:

a) on the finished instruments;
b) on the dials;
c) on a sample placed on a standard support made of stainless steel having a reflectivity between 0.2 and 0.3, comprising a circular coupelle containing a circular cup (*see* Fig. 1) with a surface area of 1 cm^2, intended to hold 50 mg of powder;
d) on standard hands; and
e) on the rectangular support defined for the checking of the colours (*see* **5.2.2**).

5.2 Colours

5.2.1 *Standard Colours*

The standardized colours are the following:

C 1 – White,
C 3 – Yellow,
C 5 – Greenish-Yellow,
C 7 – Green, and
C 9 – Blue/Green

5.2.1.1 Other colours may also be used as agreed between the manufacturer and the user.

5.2.2 *Checking of Colours*

Colours of the deposits shall be checked on five standard deposits as defined in **5.1**(c) by visual examination, in day-light, without sun, for each production batch of radioluminescent substance and each time the nature of binder is altered.

5.2.2.1 The colour shall be compared with those of reference standard consisting of 50 mg of non-activated luminescent powder deposited on a surface of 1 cm^2 at one end of a standard support of the following design (*see* Fig. 2) made of stainless steel having a reflectivity between 0.2 and 0.3. The reference standards shall be stored in the dark.

FIG. 2 STANDARD SUPPORT

5.2.3 Checks shall be the responsibility of the manufacturer of the radioluminescent substance. However, if a user applies the radioluminescent substance in conditions which differ from those

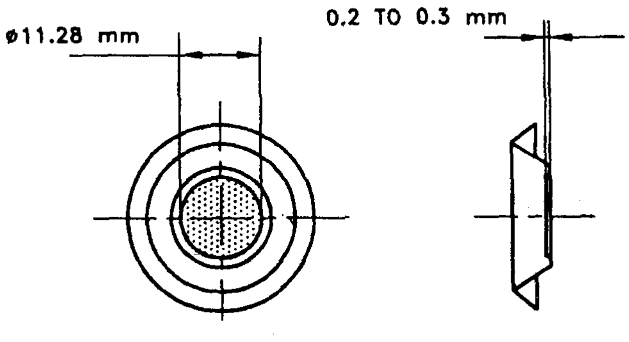

FIG. 1 CIRCULAR CUP

specified by the manufacturer of this substance (proportion and nature of the binder), the checks shall be the responsibility of such a user.

5.3 Specific Luminous Intensity

The quality of the deposits is characterized by their luminous intensity per unit mass of powder when they are examined in layers of 50 mg of powder per square centimetre, on a support having a reflectivity between 0.2 and 0.3.

5.3.1 *Allocation of Quality Classes*

It is recommended that the specific luminous intensities expressed in microcandelas per gram of powder (μcd/g), be included between the intervals given in Table 5.

5.3.2 *Checking of the Specific Luminous Intensity*

The deposit shall be applied on a standard support as specified in **5.1**(c) for each production batch of radioluminescent substance and each time the nature of binder is altered.

5.3.2.1 The luminous intensity shall be checked after the luminescent deposit has been kept in darkness for at least three hours.

Table 5 Specific Luminous Intensities

(*Clause* 5.3.1)

Class	Values in microcandelas per gram	
	Minimum Value	Maximum Value
L1	2.5	3.15
L2	4	5
L3	6.3	8
L4	10	12.5
L5	16	20
L6	25	31.5
L7	40	50
L8	63	80

NOTES

1 The minimum values indicated are imperative, while the maximum values are only given as an indication.

2 If necessary, supplementary classes 9, 10, etc, may be introduced by using the R5 series of preferred numbers.

5.3.2.2 The characteristics of the reference standards used for this measurement and the radioluminescent deposits shall be similar. They shall present a satisfactory stability and be periodically checked by a recognized agency.

5.3.2.3 The luminous intensity shall be evaluated in relation to the mass of the powder in the deposit, in conformity with the specifications given in **5.3.1**.

5.3.2.4 Checks shall be the responsibility of the manufacturer of the radioluminescent substance. However, if a user applies the radioluminescent substance in conditions which differ from those specified by the manufacturers of this substance (proportion and nature of the binder), the checks shall be the responsibility of such a user.

5.4 Resistance to Ageing

Shall be checked on five standard deposits as defined in **5.1**(c) for each production batch of radioluminescent substance and each time the nature of binder is altered.

5.4.1 *Nature of the Test*

It is considered that simultaneous exposure to heat, humidity and activating light constitutes a test of accelerated ageing which simulates validly the conditions of real ageing.

5.4.2 *Procedure*

Heat a crystallizer (a glass container in the form of a cylinder with a flat bottom) containing water to a temperature of 45°C to 50°C. When this temperature is obtained, introduce the deposit on a support which must not be immersed. Cover the crystallizer with a filter transparent to ultraviolet radiation having a wavelength greater than 300 nm (for example, a Schott WG 280 filter).

Expose the deposit to the radiation of a high pressure mercury lamp (for example, OSRAM, Ultra-Vitalux of 300 W). The standard duration of exposure is 3 h at a distance of 300 mm for a 300 W lamp (As a reference value, the standard ultraviolet irradiance at 300 mm is 3 mW/cm^2).The actual duration of exposure shall be adapted to the irradiance produced by the lamp used.
No condensation shall be observed under the filter.

5.4.3 *Estimation of the Resistance to Ageing*

The luminous intensity of the deposit shall be measured before and after the test. The loss in luminous intensity, measured at the latest 5 h after the end of the irradiation, shall be less than 10%.

NOTE — A test conducted for more than 3 h allows estimation of the resistance to 'greying' (deterioration of the colour of the deposit).

5.4.4 Checks shall be the responsibility of the manufacturer of the radioluminescent substance. However, if a user applies the radioluminescent substance in conditions which differ from those specified by the manufacturer of this substance (proportion and nature of the binder), the checks shall be responsibility of such a user.

5.5 Adhesion

The radioactive material should be bound in the luminous compound in a not readily soluble form; either by means of its chemical composition or with the help of a binding agent.

5.5.1 *Procedure for Dials and Rigid Components*

The dials and rigid components shall be subjected to a sinusoidal vibrations communicating an acceleration of over 20 m/s^2(peak value), at a selected frequency between 25 and 100 Hz, for a period of time such that the frequency multiplied by the time, expressed in seconds, is equal to 90 000.

5.5.2 *Procedure for Hands*

a) Hands with a length of 15 mm or less shall be bent round a cylinder with a radius of 12.5 mm.
b) Hands with a length of over 15 mm shall be bent round a cylinder with a radius equal to the length of the hand, with a tolerance of ±1 mm.
c) If, in the case of special designs, it is not possible to bend the hands round a cylinder, they shall be subjected to the vibration test specified for rigid components (*see* **5.5.1**).

5.5.3 *Estimation of Adhesion*

Following these tests, examine the dials and hands as well as their immediate surroundings. The presence of alterations, such as splits and cracks or of perceptible debris shall be considered grounds for rejection. Detached particles are revealed by means of an ultra-violet lamp.

5.5.4 *Checking of Adhesion*

The adhesion of the radioluminescent substance on dials and hands of time pieces shall be such that, under normal conditions of use, it remains fixed on these components. The adhesion shall be checked.

5.5.4.1 For each production batch of radioluminescent substance and for each batch of binder, on the five standard supports, the checks shall be the responsibility of the manufacturer of the radioluminescent substance.

5.5.4.2 For each new support or new deposit which has not undergone testing by the user concerned, on at least five pieces, the checks shall be the responsibility of the user of the radioluminescent material, that is, manufacturer of dials.

5.5.4.3 For each production batch of dials or hands or any part bearing a radioluminescent deposit, on a representative sample ensuring an acceptable quality level (AQL) of 1 percent. These checks shall be the responsibility of the user of the radioluminescent substance.

5.6 Swipe Test for Dials

The luminous painted dials shall be dried and kept in an oven at 50°C for 15 min. After cooling to room temperature, the luminous markings shall be wiped gently using dry surgical cotton or brush No. zero. There shall be no spread of the paint.

5.7 Insolubility

5.7.1 *Procedure*

Immerse the deposit to a depth of at least 3 mm for 24 hours in distilled water, at a temperature between 18°C and 25°C. Then measure the activity of the water. For 50 mg of deposit, it shall be less than:

100 μCi (3.7 MBq) for Tritium deposits, and
6 μCi (0.2 MBq) for Promethium deposits.

5.7.2 Checking of Insolubility

Carry out checks on standard deposits as defined in **5.1**(c) which have been prepared in accordance with the instructions of the manufacturer of the luminous powder and which have undergone the test specified in **5.5.1**. Quality control may also be carried out on luminous components (dials and hands) which have undergone the tests specified under **5.5**. The mass of the powder in the deposit shall then be measured or calculated, the maximum authorized activity of the water being considered proportional to the mass of the powder in the deposit, regardless of its activity.

5.7.2.1 The insolubility shall be checked for each production batch of radioluminescent substance and for each production batch of binder, on the standard support used for checking of adhesion. These checks shall be the responsibility of the manufacturer of the radioluminescent substance.

5.7.2.2 On the new supports which were used for the checking of adhesion, when the new element concerns the support material or the surface treatment of the support, the checks for insolubility shall be the responsibility of the user of the radioluminescent substance.

6 CERTIFICATE OF CONFORMITY

6.1 The manufacturer of the radioluminescent substance shall be required, at the request of the customer, to furnish a certificate with each delivery, indicating the batch number, and stating the characteristics defined in **5.2** and **5.3** for one or more types of binder and for one or more proportions of mixtures, and conformity of the product with the details specified in **5.4** to **5.7**.

6.2 The user of the radioluminescent substance shall be required, at the request of the customer, to furnish a certificate with each delivery of hands or dials guaranteeing the use of a radioluminescent substance.

6.3 Both the manufacturer and the user of the radioluminescent substance shall be required, with due regard to national regulations applying to prescribed time limits, to file the reports on checks carried out on their production as well as duplicate copies of certificates accompanying deliveries and to produce them on demand.

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